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AUTHOR Hershey, Douglas A.; And Others
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ABSTRACT

Although criteria for the diagnosis, prognosis, and treatment of Alzheimer's disease (AD) have become better defined, few research findings have appeared in the literature which characterize the degenerative course of the disease. Of particular interest to both clinicians and researchers would be a study focusing on changes in the patient's cognitive and behavioral abilities over time. This study measured the changes in cognitive and behavioral abilities displayed by Alzheimer's disease patients over a period of 6 months. Data were collected as part of a large-scale, ongoing longitudinal research project. Subjects were 5 males and 11 females meeting criteria for probable AD. The mean age of the sample ws 76.4 years and the average level of education was 12.4 years. The cognitive tests used included the Mental Status Questionnaire, the Mini-Mental State Examination, and the Information-Memory-Concentration test. The behavioral tests used included the Memory/Behavior Problem Checklist (MBPC) and a scale designed to assess the patient's ability to carry out activities of daily living. Subjects were tested at two points in time separated by approximately 6 months. Caregivers also completed measures of behavioral impairment. Results showed all measures except the MBPC were able to discriminate changes in patient abilities. The patients' cognitive scores at the first testing were predictive of their level of behavioral impairment at the second testing. The rate of decline for individuals was not subject to substantial fluctuation. (ABL)

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Can Brief Tests of Mental Status Predict Functional Behavioral Impairment?

Douglas A. Hershey, David M. Freed
Department of Psychology
Seeley G. Mudd Building
Los Angeles, California 90089-1061

and

Victor W. Henderson M.D.
Department of Neurology
USC School of Medicine
2025 Zonal Avenue
Los Angeles, California 90033

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Corresponding Address: Douglas A. Hershey
Department of Psychology
Seeley G. Mudd Building; MC-1061
University of Southern California
Los Angeles, California 90089-1061

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Although criteria for the diagnosis, prognosis, and treatment of Alzheimer's Disease (AD) have become better defined, few research findings have appeared in the literature which characterize the degenerative course of the disease. Of particular interest to both clinicians and researchers would be a study focusing on changes in patients' cognitive and behavioral abilities over time. Such research could yield important implications for the management and treatment of the disease (Weintraub, Baratz, & Mesulam, 1982). In particular, longitudinal research designs could provide valuable insights into: (i) the extent to which we can successfully measure declining cognitive and behavioral abilities, (ii) the parallel between changes in both realms of functioning and (iii) the stability (uniformity) of decline experienced by individuals with the disease. The present study addresses these issues by measuring the changes in cognitive and behavioral abilities over a time-span of six months displayed by patients with AD.

For our measures of cognitive ability, patients received three commonly used brief tests of mental status. In addition, two scales designed to assess individuals level of behavioral impairment were completed by the patients' caregiver (typically a spouse). The cognitive tests included the Mental Status Questionnaire (MSQ) (Kahn, Goldfarb, Pollack, and Peck, 1960), the Mini-Mental State Examination (MMSE) (Folstein, Folstein, and McHugh, 1975), and the Fuld adaptation of the Blessed et al. Information-Memory-Concentration test (IMC) (Fuld, 1977; Blessed, Tomlinson, & Roth, 1968). The measures of behavioral impairment included the Memory/Behavior Problem Checklist (MBPC) (Zarit & Zarit, 1983), and a scale specifically developed to assess patients' ability to carry-out activities of daily living (USCADL). All of the measures with the exception of the USCADL have been previously shown to be both reliable and valid.

The degenerative course of the disease leads to straightforward hypotheses with respect to changes in cognitive and behavioral abilities. First, it is hypothesized that individuals' scores for each of the three cognitive measures should be found to decline between test sessions. Second, patients' levels of behavioral impairment should show increases between time one (T1) and time two (T2). In addition, we explored the extent to which a patient's behavioral impairment at T2 can be adequately predicted from their level of cognitive functioning at T1. Moreover, the degree to which subjects display uniform rates of change (in both the cognitive and behavioral realms) was investigated.

Methods

Subjects

The data used in the present analyses were collected as part of a large-scale, ongoing longitudinal research project conducted by the Alzheimer's Disease Research Center at the University of Southern California. Subjects were five males and eleven females meeting NINCDS-ADRDA criteria for probable AD (McKhann, Drachman, Folstein, Katzman, Price, & Stadlan, 1984). The mean age of the sample was 76.4 years (sd = 8.6), and their average level of education was 12.4 years (sd = 3.9). All of the subjects were recruited into the project on a strictly voluntary basis. None were paid for their participation.

Research Instruments

Cognitive tests. All three of the cognitive measures possess a number of shared characteristics. First, the MSQ, the MMSE, and the IMC are typically used as screening instruments in that they provide a global evaluation of mental functioning. All of the tests have displayed good test-retest reliability and have further been found to discriminate demented individuals from neurologically "normal" contrast subjects. The MSQ is the briefest of the three tests containing ten items, the MMSE consists of twenty questions[1], and the IMC thirty-three. Items on the MSQ test for recent memory and orientation (for time and place). In addition to these abilities, the MMSE assesses registration, attention, language, and praxis. The IMC focuses on orientation, remote memory, recent memory, and concentration. Appendix A is a compendium of the items found in the three measures, and identifies which test(s) a given item appears on.

Scores on the MSQ (possible range 0-10) and the MMSE (possible range 0-35) are derived by counting correct responses, while on the IMC (possible range 0-37), errors are summed. However, for purposes of consistency and ease of interpretation, the present study reports patient's scores on the IMC as the number of correct responses. All three of the tests have been found to be highly intercorrelated. However, to some extent, this is due to the fact that the instruments share a number of common items (see appendix A).

Measures of Behavioral Impairment. The MBPC is a 31 item rating device used to assess how frequently demented patients engage in common problem behaviors (e.g.,

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[1] Actually, the original MMSE contained 19 questions. However, one item--spell "world" backward--could be substituted for an item requiring subjects to count backward from 100 by 7's. Yet, since these two items might be thought to sample distinct cognitive abilities, the decision was made to include both items in the present study. It should be noted that this increases the number of total points possible by five.

asking the same question repetitively; wandering or getting lost; destruction of property; difficulty concentrating on a task). The scale was designed to be completed by the patient's caregiver or another informant who knows the patient well. The frequency of problems are scored from 0 - 4 (0 = behavior never occurred; 1 = has occurred infrequently [not in past week]; 2 = has occurred 1 or 2 times in past week; 3 = has occurred 3 to 6 times in past week; and 4 = occurs daily or more often). A total score for this measure is obtained by summing the scores over the 31 items. Therefore, scores on the test can range from zero (no memory/behavior problems) to 124 (severe problems).

The second measure of behavioral impairment, the USCADL, is an 18 item scale which was designed to assess patient functioning in the following five areas: personal care, household care, work and money, communication, and activities (see appendix B). Caregivers are required to rate patients' ability to carry-out specific activities of daily living using a score of 0-3, where a zero indicates normal functioning and three represents a problem in executing a particular behavior. Items for the USCADL scale are a combination of problem behaviors represented in the Instrumental Activities of Daily Living scale (Lawton & Brody, 1969) and the Blessed Dementia Scale (Blessed et al., 1968). A total score for the measure (maximum possible = 54) was derived by summing the item scores for all 18 questions.

Data Collection

All subjects were tested individually at the University of Southern California ADRC at two points in time separated by approximately six months ($\bar{X}$ = 195 days, sd = 23) as part of an ongoing longitudinal study of aging. The unique items from each of the three cognitive tests were combined into a single "composite" test (COMP) consisting of 48 questions (66 possible points). During the test session, caregivers took the opportunity to complete the measures of behavioral impairment.

Results

For purposes of analyses, item scores on the COMP test were broken down to reflect the number of items correct for each the MSQ, the MMSE, and the IMC. Therefore, all of the following statistics are based on four individual (although not independent) cognitive scores for each of the sixteen patients.

In order to determine whether or not our measures were sensitive to the patients' cognitive and behavioral decline, two sets of paired t-tests (one-tail) were carried out. All of the cognitive measures were found to be significantly different

(the MSQ: $t[15] = 2.78$, $p < .05$; the MMSE: $t[15] = 4.48$, $p < .01$; the IMC: $t[15] = 5.23$, $p < .01$; and the COMP: $t[15] = 6.41$, $p < .01$), indicating that the tests were, in fact, reflecting the patients' decreasing cognitive abilities. For the behavioral scales, the USCADL demonstrated a significant increase from T1 to T2 ($t[15] = 2.92$, $p < .01$). However, our second scale of behavioral impairment, the MBPC, failed to reflect the hypothesized increase between test sessions ($t[15] = .37$, n.s.). Mean test and difference scores for each of the six measures can be found in Table 1. Bonferroni corrections were used for both the cognitive ($C = 4$) and behavioral measures ($C = 2$) in order to avoid exceeding the analysiswise type one error rates (set at .01 and .05 at the beginning of the experiment).

Next, a set of bivariate regression analyses were executed to determine if patients' cognitive ability scores at T1 were predictive of their level of behavioral impairment at T2. Since the MBPC failed to prove sensitive to change, regressions were run using the USCADL (T2) as the criterion variable, and the four cognitive scores (T1) as the predictors. All four regressions were found to be statistically significant at the .01 level (USCADL.MSQ: $F[1,14] = 25.56$; USCADL.MMSE: $F[1,14] = 28.09$; USCADL.IMC: $F[1,14] = 27.62$; USCADL.COMP: $F[1,14] = 28.59$). In essence, this finding demonstrates that the brief global tests of cognitive status are indeed predictive of a patient's level of behavioral abilities.

Finally, in an attempt to determine the extent to which the change experienced by patients is a gradual (as opposed to stepwise) process, Kendall's Tau rank-order correlation coefficients were calculated for each of the five measures with themselves at T1 and T2 (excluding the MBPC). With this test, a high positive correlation (tau nearing +1.0) would indicate that the relative ranks of patients were preserved from T1 to T2 on a given measure. The degree of association for the five tests were all found to be highly significant ($\tau_{MSQ/MSQ} = .73$ [$p < .01$]; $\tau_{MMSE/MMSE} = .75$ [$p < .01$]; $\tau_{IMC/IMC} = .77$ [$p < .01$]; $\tau_{COMP/COMP} = .77$ [$p < .01$]; and $\tau_{USCADL/USCADL} = .45$ [$p < .05$]), suggesting that both the cognitive and behavioral changes are best characterized as a reflecting a gradual process.

Discussion

First, it was determined that all of the measures, with the exception of the MBPC, were able to discriminate changes in patient abilities across a six-month period of time. Both practitioners and researchers interested in the measurement of change in AD patients might find this result useful in the design phase of future work. In clinical

settings, where cognitive measures are typically required to be efficient as well as valid, the (relatively) short MSQ test would most likely be the measure of choice. However, in the laboratory, where future work is likely to focus on changes in specific abilities, the COMP test might be preferred in that it samples a far wider range of mental abilities. Such a test could be successfully used in a factor analytic study where the aim would be to identify the order and magnitude of decline for particular subsets of cognitive skills. It is critical to note though, that the four cognitive measures should not be seen as equivalent in that they all were found to discriminate declines in abilities over time. As pointed out above, each of the tests assess different areas of cognitive functioning (e.g., memory, orientation, language, praxis, etc.), which will allow the researcher/practitioner to select the instrument which best meets his or her needs. Furthermore, the finding that the USCADL is sensitive to change makes this scale attractive to those who are interested in assessing increasing levels of functional behavioral impairment (e.g., nursing home administrators, outpatient care facilities).

Second, the fact that patients' cognitive scores at T1 were predictive of their level of behavioral impairment at T2 should be viewed as particularly intriguing by those interested in long-term care and health planning issues. In short, these results suggests that the behavioral changes experienced by AD patients closely parallel their cognitive decline, a question which until now has remained unanswered in the literature (Weintraub, Baratz, & Mesulam, 1982). This finding has clear implications for those interested in research designed to further the development of long-term health-care policies.

Third, the issue of whether or not cognitive and behavioral declines are gradual or stepwise was successfully addressed by demonstrating that the rate of decline for individuals was not subject to substantial fluctuation. That is, while not all subjects showed the same degree of change from T1 to T2, the changes they did experience were roughly equivalent (at least to the extent that their relative rank order remained stable).

It is recognized that the generalizations regarding change over time in the present work are limited due to the fact that measurements were only taken on two occasions. Ideally, to validate the above findings, one would want to measure changes using cognitive and behavioral instruments on a number of different occasions. In effect, one could then determine the extent to which the patterns of change identified above are constant throughout the course of the disease. Unfortunately, such studies are difficult to conduct for a number of reasons (e.g., difficulties in identifying subjects early on in the course of the disease; subject attrition after the T1 measurement, etc.).

Nonetheless, it is felt that this work represents a good first effort in measuring changes occurring in both the cognitive and behavioral realms.

In sum, based on the above findings it appears safe to conclude that: (1) brief tests of mental status (the MSQ, the MMSE, the IMC, and the COMP) are sufficient to measure the declining abilities of Alzheimers' patients, (2) the USCADL was sensitive to increases in behavioral impairment from T1 to T2, while the MBPC was not, (3) the cognitive measures are indeed predictive of patients levels of behavioral abilities six months down the road, and (4) both the cognitive and behavioral changes experienced by AD patients can be characterized as gradual, not stepwise, processes.

Although our understanding about the etiology, progression, and treatment of AD is still in its infancy, it is felt that the present findings serve to advance our knowledge of the cognitive and behavioral changes AD patients reflect over a relatively short period of time (six months). Furthermore, it is our hope that future research efforts will employ longitudinal design strategies thereby increasing the likelihood that we can come to better understand the progressive nature of the disease.

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Table 1

Means and mean difference scores for each of the six measures

Type of Measure	Mean score at time one	(SD)	Mean score at time two	(SD)	Difference Score
Cognitive					
MSQ	2.6	(2.9)	1.8	(2.3)	.8 *
MMSE	13.2	(8.7)	9.7	(8.3)	3.5 **
IMC	12.7	(9.1)	8.4	(7.7)	4.3 **
COMP	24.5	(16.3)	17.2	(14.6)	7.3 **
Behavioral					
MBPC	48.9	(16.2)	50.7	(26.4)	-1.8
USCADL	34.0	(10.8)	39.6	(9.1)	-5.6**

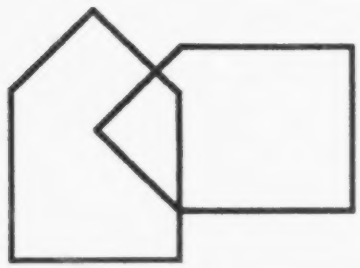
* $p < .05$

** $p < .01$

Appendix A
(Items appearing on the COMP test in order of administration)

	Originally appearing on			
	MSQ	MMSE	IMC	Possible points
1. What is your full name?			•	1
2. What is your exact age?	•		•	1
3. What is your date of birth?	•		•	1
4. What is your year of birth?	•			1
5. What was your place of birth?			•	1
6. Where are you now? (i.e., name of facility)	•	•	•	1
7. What kind of place is this? (e.g., hospital, university, etc.)			•	1
8. Where is it located?	•		•	1
9. On what street is the place that you live?			•	1
10. How long have you been there?			•	1
11. What city are we in?		•	•	1
12. What country are we in?		•		1
13. What state are we in?		•		1
14. What floor are we on?		•		1
15. What is the date today? (month & date; e.g., March 21st)	•	•	•	2
16. What year is it now?	•	•	•	1
17. What is the day today? (e.g., Tuesday)		•	•	1
18. What part of the day is it? (e.g., morning, afternoon, etc.)			•	1
19. What time is it? (within one hour)			•	1
20. What season is it?		•	•	1
21. Repeat following address. (John Brown, 42 Market St., Chicago)			•	1
22. What was (is) your mother's first name?			•	1
23. How much schooling do you have?			•	1
24. What school did you go to?			•	1
25. What kind of work have you done.			•	1
26. Who is president of the United States?	•		•	1
27. Who was president before him?	•		•	1
28. When was World War I? (any year between 1914 and 1918 correct)			•	1
29. When was World War II? (any year between 1939 and 1945 correct)			•	1
30. Name months of year backwards.			•	2
31. Count from 1 to 20.			•	2
32. Count backwards from 20 to 1.			•	2
33. Recall first name of person in question 21. (John)			•	1

	Originally appearing on			
	MSQ	MMSE	IMC	Possible points
34. Recall last name of person in question 21. (Brown)			•	1
35. Recall street number of person in question 21. (42)			•	1
36. Recall street name of person in question 21. (Market St.)			•	1
37. Recall city of person in question 21. (Chicago)			•	1
38. Repeat three words: Ball, Flag, Tree.		•		3
39. Count backwards from 100 by 7's.		•		5
40. Spell "WORLD" backwards.		•		5
41. Ask person to recall words presented in question 38.		•		3
42. Show patient wrist watch and ask him/her to identify it.		•		1
43. Show patient a pencil and ask what it is.		•		1
44. Ask patient to repeat: "No ifs, ands or buts."		•		1
45. Ask patient to execute a three-stage command.		•		3
46. Have patient read and follow a written command. (close your eyes)		•		1
47. Ask patient to write a sentence.		•		1
48. Show patient the figure below and ask him/her to copy it.		•		1



Appendix B: University of Southern California Activities of Daily Living Scale*

PERSONAL CARE

1. Eating
   - 0 Normal
   - 1 Independent, but slow or some spills
   - 2 Needs help
   - 3 Must be fed most foods

2. Dress
   - 0 Normal
   - 1 Independent but slow or clumsy
   - 2 Needs help
   - 3 Needs help with all clothes

3. Grooming
   - 0 Same as always
   - 1 Interested if going out, not when staying at home
   - 2 Allows self to be groomed
   - 3 Resists efforts of caregiver

4. Pills
   - 0 Remembers without help
   - 1 Remembers if dose left out
   - 2 Tries but forgets
   - 3 Must be given by others

5. Bathing
   - 0 Bathes (or showers) without reminding
   - 1 Bathes (or showers) but needs reminding
   - 2 Bathes (or showers) but needs assistance
   - 3 Must be done by others, or unwilling to bathe

6. Elimination
   - 0 Goes to bathroom independently
   - 1 Goes when reminded, occasional accidents
   - 2 Needs assistance
   - 3 has no control of either bladder or bowels (doubly incontinent)

HOUSEHOLD CARE

7. Meals
   - 0 Plans or prepares meals
   - 1 Less than normal
   - 2 Gets food out if prepared by others
   - 3 Does nothing

8. Housekeeping
   0 As usual
   1 Does at least half
   2 Occasional dusting, small jobs
   3 No longer keeps house

9. Maintenance
   0 As usual
   1 Does at least half
   2 Occasionally rakes, minor jobs
   3 No longer does any

10. Repairs
   0 As usual
   1 At least half
   2 Occasional minor repairs
   3 No longer does any

11. Shopping
   0 As usual
   1 With difficulty
   2 With assistance
   3 Unable

WORK AND MONEY

12. Job
   0 As usual
   1 Some trouble, but still at same job
   2 At easier job, part time, or trouble finding a job
   3 No longer works

13. Money
   0 As well as usual
   1 Trouble with checkbooks or decisions
   2 Most management done by others
   3 No longer handles money

COMMUNICATION

14. Phone
   0 As usual
   1 Calls a few familiar numbers
   2 Can answer phone only
   3 Cannot use phone

15. Writing
   0 As usual
   1 Less often
   2 May sign name, leave message, or short list
   3 Unable

ACTIVITIES

16. Staying alone
    0 As usual
    1 Can be left for a few hours
    2 Can be left for a few minutes only
    3 Cannot be left alone

17. Walking
    0 As usual
    1 Slower than usual
    2 Unsteady or shuffling gait
    3 Unable to walk

18. Watching television
    0 As usual
    1 Watches more than usual
    2 Watches less than usual (may watch for brief periods)
    3 No longer able to watch

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* This form of the USCADL is for illustrative purposes only. A more detailed form of the scale is available upon request from: Douglas A. Hershey, Department of Psychology, University of Southern California, Los Angeles, California 90089-1061